248. *Eriod. vernalis*, n. sp.

Minor, alis ant. elongatis, ochreo-griseis, creberrime cano-conspersis ; post. dilute griseis.

♂. 14-16 mm. Head, palpi, antennæ, thorax, abdomen, and legs grey-whitish ; anterior legs dark fuscous Forewings elongate, narrow, costa moderately arched, apex pointed, hindmargin extremely obliquely rounded ; ochreous-grey, densely irrorated with white : cilia white, irrorated with grey. Hindwings light grey or whitish-grey ; cilia grey-whitish.

One of the very earliest spring insects, easily neglected.

Sydney, New South Wales ; four specimens in August.

Notes on the Geology of the Southern Portion of the Clarence River Basin.

By Professor Stephens.

The Delta of the Clarence River, now notable throughout Australia as a district in which the Sugar Cane can be profitably cultivated by free white labour, lies, like all the deltas in New South Wales, entirely inland. The strong current which sweeps along the eastern coast, and maintains by means of its tepid waters a subtropical climate and vegetation as far south as Illawarra, also carries away to the southward and to sea all the mud and fine sediments which are discharged by this and its sister rivers. Only the heavy siliceous silt remains behind, which, together with the sands pounded out of the sea cliffs by the unceasing action of the waves, forms at the mouth of every estuary a curving line of dunes, concave to the sea, and resting at each extremity upon headlands of solid rock. The immunity from winter cold and spring frosts which the Clarence enjoys more than any river to the south, and more than most to the north, until the Tropic is

actually reached, depends in part I suppose on its extremely low seaboard, partly on the vast quantities of warm sea water which are drawn in with every tide, and partly upon the free and well-drained character of the sugarlands.

The result of these advantages, the sugar industry of the Clarence, presents a really astonishing spectacle. Industrial activity of any kind, however striking it may be to the visitor, is not indeed a subject for the consideration of this Society. But having been recently enabled to visit the district, and to make the trip from Grafton on the Clarence to Glen Innes on the Table land, and back again, I had an opportunity of making some observations on the Geological structure of that part of the country, which I hope may be worth some attention. There is more repetition in the paper than I could wish; but it seemed to me while writing that with more condensation I might become less intelligible. "*Brevis esse laboro, obscurus fio.*"

The road from Grafton to Buccarumbi, with which we are principally concerned, runs through a poor country of sandstones and shales, undulating in the valleys, but broken by ranges of mural precipices closely resembling the escarpments common in the Hawkesbury sandstone. The false bedding or oblique stratification so common in the latter series is equally predominant here; and the rock faces are excavated by atmospheric action into caves or "gibber gunyas" of exactly the same character as those on the shores of Port Jackson or in the gullies of the Blue Mountains. The vegetation is also so similar that it is only by a kind of effort that one remembers that the formation is not the same. A hill beyond the river Orara is capped with quartz boulders and gravel. To this I shall refer in its proper place. Quitting the main basin of the Orara by the line of the Chambigne Creek, and over a range covered with a fine open forest of spotted gum and ironbark, we descend to the OBX Creek over a road metalled with petrified wood. This gully is the most interesting geological feature which we have yet observed. For the right bank of the Clarence receives its waters partly from the coast ranges by the Orara, and partly from the south and west.

The basin of the former is carboniferous—that of the latter Devonian, Silurian, *or older*. Along the boundary runs the OBX, having on its left the rocks of vertical, on its right bank those of horizontal stratification. If we examine the sections displayed upon the right, we shall observe at the basis a conglomerate of small pebbles, over which lies a felspathic looking sandstone. Above this again is seen a bed composed mainly of petrified trees, apparently coniferous, and highly charged with oxide of iron. Above follow shales and sandstones, in which seams of Coal are known to occur. Coal indeed is everywhere indicated in these horizontal beds, and many seams have been proved, as at Rocky Mouth, but as yet without very satisfactory result. Turning to the left or western bank we find the road ascend by a side cutting, displaying those familiar schists and slates which for want of a better name we call Siluro-Devonian. Here and there we observe patches of horizontal conglomerate resting upon their upturned edges, and on the summit we find a massive capping of the same. As we descend, we lose it, though scattered pebbles from that source are still to be seen on the surface.

At Buccarumbi we cross the Nymboi, just below its junction with the Boyd, or Little River, up which we run, through schists, hard slates, and quartzites, to Broadmeadows, where we leave it (in granite) for the Henry or Newton Boyd River, a tributary of the Mann or Mitchell. (Every river here has an *alias* or two.) After crossing the former we strike the right bank of the latter, and keep it more or less until we cross this also just before the ascent to the table land. The road all the way from Broadmeadows winds over a tract of soft and decomposing granite forming a steeply undulating surface enclosed and invaded by impassable ranges of greenstone, or equally forbidding rock. The river bottoms however are floored with extremely hard, that is, undecomposed granite. A spur of this softer granite, the Big Hill, carries the road up 2000 feet higher, to the open granitic downs, black soil flats, and rich agricultural lands formed by the decomposition of volcanic rock, which form the superficial riches of New England.

Returning to the Orara range and taking our stand upon the summit we have immediately beneath our feet the conglomerate mentioned above, a more recent portion of which same formation is the basis of the Clarence Carboniferous series, which extends eastwards without visible break, though enormously eroded, all the way to the Pacific. This capping of the hill rests upon an uneven surface of slates, schists, and quartzites, vertical or nearly so, and extending westwards to the greenstones and granites which form the eastern buttress of the tableland.

The range, as has been already said, forms the division between the basin of the Orara or S.E. tributary of the Clarence, (which rising near the coast runs in a north-easterly direction to join the river above Grafton), and that of the south-western waters, which are gathered from the vast alpine mass rising to the eastward of Armidale, and known in different parts by different names, as Mount Lofty, Macleay Range, Chandler's Peak, &c. It is a spur of the main watershed or Great Divide, starting from Ben Lomond, and separating the upper waters of the Clarence and Manning Rivers. Much of it is laid down in the Geological Map as volcanic; more, I venture to predict, than will be admitted bye and bye. Its northern slopes are drained by the various torrents which make up the Nymboi, Guy Fawkes and Mitchell Rivers, and pass to the northwards between us and the table land. The Guy Fawkes takes a sudden turn to the west, nearly S. of Newton Boyd, and under the name of Little River or Boyd, joins the Nymboi at Buccarumbi, having been probably been diverted from its original course by the elevation of the Newton Boyd greenstones and granites.

For the whole channel of the Boyd or Little River as we trace it westwards and upwards from Buccarumbi, where it joins the Nymboi, to Broadmeadows, where we leave it for the Henry or Newton Boyd River, is a deep gutter eroded in slates and quartzites, generally of intense hardness, in a direction at right angles to their strike. A similar and parallel channel, about 15 miles to the north carries the waters of the Mitchell to the Nymboi. There is no fault traversing these beds in a direction at right

angles to their strike, which might have been invoked, against all reasonable probability, to explain the direction of the drainage. The harder beds of rock are quite continuous from the north to the south bank; they form projecting spurs on each, which are connected by transverse bars or ridges, forming shelves and rapids in the stream, as they still reluctantly yield to ancient and interminable erosion. The Geological Map here marks an elongated stripe of igneous rock, along which the river makes its way; as if this were a softer material which had been more easily excavated than the rest. But this is evidently an error; and I cannot help suspecting that more of the Green patches in the neighbourhood have in reality no claim to that colour, but rather to Mauve.* The origin of the mistake in the case of the Little River River is not difficult of discovery. For the road along side of it is to a very large extent a ledge or cornice cut out of the solid rock, which is, as has been already observed, of a most refractory character, and would be rated in specifications, tenders, and contracts, as equal to the hardest material. At any rate I found that the name recognised in these localities for the blue flinty quartzite was *Basalt*, and hence, I presume, the error in the Map. If this be the case, it is probable that other "Green" areas in the same Roads-district, will prove to have the same origin†. In reality the whole district from OBX Creek westward as far as Broad-meadows, a few miles from Newton Boyd is of the same formation (Siluro-Devonian ?) and is probably not destitute of fossil remains; though, from the highly metamorphic character of its greater portion, they are not likely to be found easily or frequently. Gold is obtained at many points, and at Dalmorton on the Boyd, a mining township has been established, and some reefs are being worked, with not much noticeable result. In one or two spots I observed small dioritic dykes, and indications of others. But the country as a whole consists of nearly vertical slates and quartzites, with the usual northerly strike.

* *Green* in this Map signifies Dioritic and Basaltic (Volcanic and Trappean); *Mauve*, Silurian formations.

† I have been informed that the coarse sand which forms by the decomposition of granite is known in N. S.W. Railway contracts as *Gneiss*. Out of this misnomer strange confusion might arise.

But to return to the conglomerate at the top of the Orara range. It occupies an ancient river bed, now the summit of a hill more than 900 feet above the sea. It is composed of pebbles large and small, all well rounded, of ellipsoidal shape, and composed of hard slates, &c., without quartz. It contains patches of coarse sandstone, bedded at various angles, and composed of river sand, with few, if any, separate grains of quartz. There can be no doubt as to its fluviatile origin; and it is probable that it represents a somewhat deep portion of the bed, where the shingle might have been consolidated by cement before the waters had deserted that part of their course: for it seems clear that this bed of concrete served to protect the portion of the range immediately beneath it from the waste which the rest has suffered. Again, down the eastern slope of the range we come upon other shelves or patches of the same material, the pebbles diminishing in average size, but otherwise the same, until at last in the bottom of the creek we see it emerging upon the right bank from the loose shingle of the torrent bed, and forming, as has already been said, the basis of the horizontal series. It is not to be supposed that this conglomerate underlies that series throughout. It is clearly, I think, a river shingle, and cannot be supposed to extend very far to the eastward of OBX. Upon what then does it rest, and what is the formation upon which the Clarence River beds have been deposited? The conglomerate showing first as a cap to the range, secondly as a series of shelves upon the western or left hand slope, and finally as the bottom rock of the escarpment on the eastern or right bank, seems to give one half the answer; and the disappearance of the older rocks East of the range, to complete it. I suppose the river which formed the upper conglomerate to have run northwards along a line of fault in the Slates. This line is now marked on the map by the division between the Silurian and Clarence River beds, and on the ground, at least in part, by OBX Creek. I suppose further that the lowering of the river was mainly due, not to erosion, which could have had comparatively little effect upon a bottom so well protected by deep shingle, but by the gradual descent of the whole country

to the East of the fault. This would by slow degrees leave the left bank as a steep slope overhanging the river, capped with the oldest shingle, and stepped by the latter and lower drift in shelves as described; until at last the downward movement of the seaward side was arrested, and the bottom conglomerate began to be formed. It would seem that at this period the landscape east of the Orara range was something like what it is now, a somewhat rugged but undulating surface extending to the sea, with its coast ranges more elevated than those inland; but that it differed from the present in being formed of slates, of less hardness perhaps, and less vertical, but still of no other formation than those to the westward. The sliding movement of one side of the fault against the other gradually ceased, eased possibly by the formation of a parallel fault or set of faults near or beyond the sea margin. The existence of this second fault is supported by much probable evidence drawn from the character of the coast, and the eastward limitation of the Clarence Basin. Without at present entering into details I should refer, as an illustration, to the double line of fault which almost certainly exists in the Waianamata District, but affecting the older rocks only; one line along, or a little to the west of, the channel of the Nepean; the other, some distance to the East of the Coast. The first is partially masked by the overlying Hawkesbury sandstone; the second concealed by the sea.

At any rate there must have been such a cessation of opposite movements as I have described. For thereafter we can trace no elevation of the one side concurrent with subsidence of the other, but both portions move together, whether upwards or downwards.

And so, after an indefinite period of rest, (or perhaps of rising) the whole district began again to subside. Great lakes were gradually formed and great rivers still carrying down the debris of the wasting continent, filled up the hollows with beds of sand or mud, interspersed with drifted logs and the vegetation from their banks.

The ancient surface sank the faster under this accumulation, which by degrees obliterated every salient feature, burying all

under vast accumulations of sediment, not less probably than a thousand feet in thickness, and with a surface but little raised above the sea. Meanwhile the lower beds of this formation were becoming hardened and consolidated, the sands into sandstones, muds into shales, and the debris of swamp vegetation and timber into coal. These are the Clarence River Coal measures, which have as yet escaped any thorough investigation. The fossils which have been determined are few. Our President says of the whole series "In the Clarence River district we have certain Coal bearing strata, the relative position of which has not yet been definitely ascertained. They consist of a great thickness of conglomerates sandstones and shales. The seams of Coal as yet discovered on them are of no value, but it is not unlikely that seams of good quality will be found in the lower portion of the series. No *Glossopteris* has been found in these beds, but as they contain the *Tæniopteris Daintreei*, *Alethopteris australis*, and *Thinnfeldia*, they may be newer than the Wianamatta beds, and of the same age—Jurassic— as the Victorian Coal series, of which *Tæniopteris Daintreei* is a characteristic fossil."*

The Rev. J. E. Tenison-Woods in his paper on the Fossil Flora of the Australian Coal measures apparently identifies these Clarence River beds with the Ipswich Coal measures at Moreton Bay.†

The quarries now worked at both North and South Heads for the supply of stone for training walls, breakwater, &c., in the improvement of the entrance, yield large quantities of carbonaceous fossils, such as whole trees straight in the trunk, and branching radially like Pines, long straight leaves resembling those of Palms or of the Pandanus when split, other leaves and branching stems, shapeless lumps of carbonaceous matter,—and stems of Palm trees or Pandanus, rugose on the outside and crushed into flattened cylinders owing to the softness of the internal structure. Besides these, specimens of actually petrified wood are frequent; and in one block I clearly saw a portion of a shell evidently belonging to the

* Mineral Products of N.S.W. 1882.

† Proceedings Linn. Soc. N.S.W., 1883, p. 54.

Unionidæ. I confess that the inspection of these rocks leads me to guess at a more recent date for the formation than has been proposed. But two or three hours are quite inadequate for reasonable examination of so large a mass of fossils. Two or three months would hardly be enough.

It is not improbable however that these rocks upon the coast line are the very uppermost beds of the series, and pass into quite a different era from those inland.

However this may be, it is certain that after a very long period of subsidence, covering possibly, as hinted above, more than one geological period, a reverse action commenced, and the whole basin began to be eroded by the rivers which had filled it, and by the rainfall which as century after century rolled past, and the land rose more and more, found higher and higher elevations to work upon. So by degrees and at last the surface was carved into the familiar hill and dale, cliff and gully, which result from the erosion of horizontally stratified rocks of different degrees of hardness.

At some period during this emergence, and before the present river system was elaborated a river now represented by the Orara flowed from the south over a bed of quartz boulders and gravel. These remain here or there, as in the older or upper drift on the Orara range, as a capping to the hilltops which were originally the valley bottoms along which the river ran. The boulders are large enough to suggest floating ice as an aid in their transport. But I do not know that the hypothesis is required. They must indeed have travelled a very considerable distance, from the head of the Bellinger at least, and are not particularly well rounded. Still as we cannot even guess what fall the stream which conveyed them had from its source to their resting place, it is premature to appeal to Ice.

An example of this boulder or gravel bed may be seen on the W. side of the river on the top of the ridge as you pass upwards towards the west. These two drifts mark not exactly but roughly the beginning and the end of the Clarence River series.

Meanwhile an abundant rainfall continued to erode the eminences as the rivers deepened these channels, and the spoils of

both were borne to the ocean by the main artery, the present Clarence. For the water courses were now determined, and the great river now swept into the sea somewhere near its present mouth. But the relative levels of land and water were very different. It is likely enough that the river was swift and turbid, with a rocky bed, and a rocky sea shore on which to disembogue. The miserable eminences of rock which now break the level of the sea coast dunes were then high crags, hundreds of feet above the water, and connected by rocky ranges, which are now reefs, at almost an equal elevation. Somewhere under the sand hills which now impound the inland waters there was a deep valley or pass through which the river sped in its outward course. But the river bed of that time must lie not less than five hundred feet below the level of the present. For another oscillation had yet to take its turn. The land once more began to sink, the currents to slacken, channels to shoal, rivers to spread, swamps to form, forests to be flooded, to die, and be buried as they lay in the accumulation of sediment. In short the present period of subsidence had begun. This action is still continuing, and, if it be directly connected with the submergence of the N. E. Coast, and the growth of the Barrier reef, is likely to go on, at whatever time it may have commenced, to far remote eras of Geological time. That alluvium is still accumulating upon the surface is obvious. For the river banks are considerably higher than the ground behind, which falls away into swamps, salt marshes, and lakes ; and this elevation of the banks is of course due to the deposit of detritus in inundations. Twenty years ago, when a wall of rich tropical jungle rose directly from the waters edge, the turbid waters were strained of their sediment, by filtering through the matted underbrush and forest rubbish which then covered the ground, so that the ultimate overflow into the back lands consisted of comparatively clear water. Hence while the river was continually though slowly rising, by the increment which each flood contributed so as to embank it with natural levées, these back lands were kept more nearly at their original

level, which therefore was year by year becoming more and more depressed in relation to the river. The balance was from time to time restored by a higher flood than usual, which found its way in volume over the natural levées, formed broad sheets of water in the lower grounds, and either changed the course of the river as a whole, or at least put the lower grounds in the way of reclamation by subsidence of mud.

Since the shores have been denuded of their forest, the flood-waters naturally flow more rapidly outwards to right and left of the channel, and carry the sediment with which they are loaded into the lower grounds, where it is now chiefly deposited. Hence we may expect an increase of relative elevation, which, though small for each year, is continuous, and may perhaps be of considerable importance in another half century. The process described above may be seen in every stage; the wide and deep lake which has never received its proportionate share of alluvium; the "broad water" or huge expansion of the river over a formerly separated swamp, where the process of deposition is going on continuously during every hour of every tide; the dismal grey Casuarina marsh, where the ground has not yet been raised above the influence of the salt water; the green freshwater swamps, with their innumerable creeks and lagoons; the low moist rich meadows; and finally the fertile and well drained sugar or corn land. Thus on a small scale, and with a different flora, the Clarence is even now repeating the grand natural processes to which modern civilisation owes the fuel which is its power. And, as we have seen, a similar chain of circumstances led ages ago in the same district, to the deposit of sands and muds, and of the waste and decomposing matter of ferns, palms, pandanus, and pine trees which we recognise as the Clarence River Coal measures.

Again, the hills, whether isolated or as spurs from the main range, rise abruptly every where from the level; showing that the subaerial erosion, the debris produced by which tends to fill in and obliterate the angle between the horizontal ground and the hill slope, is more than counterbalanced by the accumulations of sediment from flood waters. These are all proofs of increasing

deposits, which would permanently raise the land, were their work not counteracted by equivalent subsidence of the foundation. For there is nowhere any sign of real elevation. The coast line within which the rocks of the Clarence basin were deposited has disappeared, and its position can only be conjecturally determined by careful examination of the palæozoic and igneous rocks which appear to the North and South of the entrance. But not only has this ancient barrier vanished, but the overlying horizontal beds also, which now, in miserable fragments, form the outworks of the land, are disappearing in their turn, partly by subsidence, partly by marine erosion, and in large measure under the exigencies of great engineering works. A few inconspicuous headlands are united by long ranges of sandhills, based in some places on rocky reefs, but, in others, filling the deep valleys through which the ancient water courses made their way to the sea. It is by rocks that once were summits of ranges, and not over the filled up channels of the drainage of tertiary times, that the present river makes to the sea. Through shifting sands currents traverse widely, shifting their course without warning or apparent reason. But where there is a rock at their level, they can only shift back and forward from it. Consequently the channel obtains a certain degree of permanence, although at the point where the accumulation of sand is shallowest, and a long way from the ancient channel, which had been eroded before to the commencement of the present period of subsidence.

It may be worth noting that in the course of the dredging operations which are being carried on at Lawrence, the "shacklebone" of a large whale, together with other portions of the skeleton, were met with at a depth of only two feet or so in the sandy drift. (The "shacklebone" is composed of the flattened cervical vertebræ, which are confluent in the true whales.) It may be presumed that the unfortunate animal had found its way into the river but was unable to find its way out, and had so died of hunger. The body must have finally grounded after long drifting by wind and tide somewhere near the place where the relics were discovered. For the bones which I examined, were

quite recent; and it must be many a thousand years since whales could have maintained themselves upon that ground. It is hardly necessary to add that no marine beds of any kind have been met with in sinking wells or the like through the alluvium, which is probably fluviatile to the very bottom, and there rests on an irregular surface of hill and dale, formed by the long and deeply eroded Coal bearing rocks. These again, in all probability rest, as has been shown, on a similarly eroded surface of Silurian or even older Slates, and these, as the Hindoo Cosmogony has it, upon the fundamental Tortoise.

Dimensions of some Gigantic Land Tortoises.

By J. C. Cox, M.D., &c.

We have in Sydney two large specimens of a Gigantic Land Tortoise. One is the property of Alexander McDonald, Esq., of Adelaide Cottage, Potts' Point, and is named "Rotumah," from the fact of his having been presented to the owner by the Chief of Rotumah. This specimen is a male.

The second is owned by Dr. Manning at Gladesville, a female.

Porter in 1813, was the first who published any record of these huge Land Tortoises, which he found from 3 to 400lbs. in weight at the Galapagos Islands. I am not at all sure as to what species these two Tortoises belong, but they are supposed to come from Galapagos Archipelago. Darwin saw two there which he says must have weighed at least two hundred pounds each.

There is a large specimen of this Tortoise at Ceylon, whose great size was considered sufficient by the inhabitants to demand a Royal Inspection—First, by the Duke of Edinburgh while on a cruise in H.M.S. Galatea, and subsequently by H. R. H. the Prince of Wales, when he landed at Ceylon on his way to India. This tortoise weighed 224lbs., but some notion of the enormous Tortoise in the possession of Mr. McDonald may be found when I mention that its weight is no less than 642lbs.

Subjoined is a record of the measurements of Mr. McDonald's Tortoise and those of the Ceylon and Gladesville specimens. The specimen at Gladesville far exceeds that of the Ceylon specimen, but